MARQUETTE
BUSINESS REVIEW

A JOURNAL OF FUNDAMENTAL BUSINESS PRINCIPLES

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A MUNICIPAL INCOME TAX FOR WISCONSIN?

by

Alan H. Smith*

Since World War II the problem of raising money to pay for the costs of local government has become more and more acute, until it is now one of the most serious problems facing the citizens of this country. The general and prolonged rise in the cost of goods and services has presented financial difficulties to all sections of society, whether private, business or governmental. But in no section is the difficulty more severely felt than in the smaller units of government. Those units do not have the wide taxing power and the breadth of administrative resources that enable the federal and state governments to cope with rising costs. The typical local authority finds itself limited in the complexity and effectiveness of the revenue-raising methods which it can apply, and all too frequently its tax base is inadequate for the increased money demands made on it.

In addition, now or in the very near future, local authorities are faced with the prospect of having to increase the actual amount of services which they carry out. This is due in the main to two factors: increase in population and increase in the amount and quality of the services which their citizens expect from them.

An increase in population is bound to add to local government costs. Often — all too often — in the past the extra costs have been postponed, principally by accepting a lower standard of services, as where an attempt is made to continue to use an existing water system to serve the needs of an expanding population. But sooner or later the costs of expansion have got to be faced.

The most dramatic impact of increasing population is already being felt in the sphere of education. The first effect of the rising birth rate is an increase in the school population far greater than the increase in the population as a whole. The burden of educational costs per head of the working population is thus bound to increase very substantially.

But the needs of an increasing population at a rising level of costs are not sufficient to account for the present problem. Those needs themselves tend to increase in quality as the citizens expect a higher and higher standard of services from local governments. Welfare concepts of government appear to be here to stay and it is a datum of the present situation that the voters expect their elected representatives to provide them with more and better services than they did in the past, such as health services with wider coverage, more effective drainage services, and so on.

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The three causes mentioned above are cumulative. The present crisis in local government finances is caused by the prospect of having to provide more services for more people at higher prices.

Wisconsin is most certainly not insulated from the factors which are increasing local government costs throughout the nation, and those costs are increasing here at a rate sufficient to pose a serious financial problem. To show the magnitude of the problem, reference may be made to the prospective increase in college enrollments. In 1958, 53,000 undergraduate students were enrolled in Wisconsin colleges. By 1968, assuming that the same proportion of the college age population continues to go to college, the enrollment is estimated to be 81,000. This is an increase of 52 per cent, and is based upon the assumption that the college age population will increase by that percentage, from 186,000 to 284,000. But the trend is for a greater proportion of the population to receive a college education and public sentiment is behind this trend. If college-going increases at the rate at which it has during the past five years, college enrollment by 1968 will probably be 131,000, an increase of 147 per cent over 1958. Expansion of college facilities on the basis even of the lower of these estimates is bound to mean a considerable increase in cost — the cost of new buildings and the cost of recruiting additional competent faculty.

Grade and high school education, being virtually universal, will only be affected by the increase in school age population, but this increase will take place earlier than that of the college population and will involve larger sums of money and affect lower levels of government. The magnitude of this problem may be gauged from some figures recently released by the U. S. Department of Education. In 1955-1956, national expenditure on school construction was $2.6 billion; in 1956-57 it rose to $2.9 billion; and for 1957-1958 it was estimated at $3 billion. Despite expenditure on this scale, it has been estimated by the U. S. Commissioner of Education, Lawrence G. Derthick, that at the start of the present school year 140,500 classrooms were needed; school building has not done much more than keep pace with the increasing school age population, so that the 70,500 school rooms built last year reduced the shortage by only 1,800 rooms.

It is natural, when local governments are faced by such an enormous addition to their already heavy financial burden, for them to turn to the state for assistance. An important source of revenue for local authorities in Wisconsin is the share they receive of the taxes collected by the state, especially the state income tax. This share is based on the residence of the taxpayer or, in the case of utilities, the location of their plant. This principal of sharing has a certain quality of arbitrariness, since local authorities, especially in modern metropolitan complexes, do not provide services exclusively for their residents, and since the location of a utility plant may be a matter of chance. But whatever may be the case for a different basis for sharing taxes, there seems to be no prospect of the state's being in a position to increase the share of its revenues which it gives to local governments. Governor Nelson has recently estimated that the revenue needs of the state government will be $40-60 million in excess of the estimated

revenue yield for the next two years. Although his budget does not call for any extra taxation in the coming year, there would clearly be a deficit calling for extra taxation if a greater part of state revenues were to be diverted to local governments.

Similar considerations apply to the suggestion frequently made that states — and even the Federal Government — should make periodic grants-in-aid on a very big scale to local governments. This only shifts the revenue problem to the state level and, in any case, aid of this kind is objectionable in that if made on a scale sufficient to solve local problems, it is likely to weaken the autonomy and initiative of local governments.

An attempt must therefore be made, at least in the first place, to meet the needs of local governments from their own resources, either by extending present means of revenue or by devising new means. Some of the extra money can be found by charging the recipient of the services for the benefits he receives. For example, water bills can be increased to cover the extra costs of operation, tolls can be charged for the use of certain roads, and there have been recent suggestions that a charge should be made in Wisconsin for admission to state parks. In a society and age where poverty is less and less important as a social factor, it may well be necessary to examine the possibility of charging for governmental services on a much wider scale than has hitherto been contemplated. But there are severe political limitations to the use of this expedient and it would be unrealistic to expect much additional revenue from this source in the near future.

The backbone of local revenue has hitherto been the property tax, which has steadily been increased in recent years to pay for the increasing costs of government. It now represents a heavy burden on the private house owner and it may be doubted whether in equity it ought to be increased any further. The size of a person's house is not necessarily a good measure of his ability to contribute to the costs of government. As the size of a family grows, the bigger is the house that is needed and in this very common case taxation will increase in proportion to the size of a family. Any just tax system must pay serious attention to a citizen's ability to pay tax and even though larger families receive larger governmental benefits, there are solid grounds for believing that the present property tax penalty on the size of families is big enough. In any case, a tax falling on the ownership of only one kind of property is bound to be arbitrary in its incidence; it will not touch the person who invests in other kinds of property and occupies a rented house, except to the indeterminate degree that his landlord can pass on the property tax in the form of increased rent. Nor should the effect of this tax on business costs be overlooked.

Thus there appears to be no escaping the conclusion that additional sources of local revenues must be found. The introduction of a sales tax for Wisconsin has been canvassed, but if adopted this tax is very likely to be needed for the extra costs of state government. Whether

or not a sales tax could make a substantial contribution to local revenues, it is essential that all possibilities should be carefully examined. Prominent among those possibilities is a municipal income tax and there is already sufficient experience of this in other states for a tentative appraisal to be made of its usefulness.

A municipal income tax was first introduced in Philadelphia. This city had suffered a great loss of revenues during the depression years of the 1930's and its financial troubles were increased by the growth of dormitory suburbs outside the scope of the city's taxing power, so that an increasing part of the city's services were enjoyed by those who made no contribution to the cost of those services. In 1939 the city imposed a 1½ per cent tax on compensation from employment and on the profits of business and professions. Corporate profits were not taxed because they were taxed by the state of Pennsylvania, which did not tax non-corporate income. The compensation and profits charged to municipal tax were those of residents wherever they were employed and of non-residents to the extent that they did work or performed services within the city. (School districts, however, taxed only residents since these were the normal recipients of the benefits of schools within each district.)

Most of the tax payable by employees is withheld by employers. As the tax is not graduated, calculation by employers is simple and there have been few errors or collection difficulties. Tax not withheld, that is, that payable by employees working outside the city and by business and professional men, is collected direct from the tax payers on the basis of the income of the preceding year. Returns are due on March 15 of income earned in the previous calendar year, accompanied by a payment of 25 per cent of the tax, the balance being payable in three further quarterly installments. Business or professional men who use an accounting year may adopt that year for tax purposes, the dates for returns and payments being correspondingly adjusted. Taxes not paid at the due date bear interest at 6 per cent per annum, plus a penalty of 1 per cent for each of the first six months of default. In 1943 the rate of tax was reduced to 1 per cent, and in 1950 it was increased to 1¼ and extended to unearned income; in 1957 the rate was increased to 1½ per cent.

The Philadelphia tax has been a complete success. Its yield has steadily increased and it now represents about one quarter of the city's revenues, almost as much as the yield of the real property tax. About one-third is paid by non-residents working in the city, thus achieving one of the main objects of the tax. It must be admitted that the cost of collecting tax from residents working outside the city is high. Fuller collection from such taxpayers has been insured by comparison of local directories with names on tax lists and by interviews with major concerns operating near the city. In 1948 a major drive took place to tighten up collections; one example of the work done was a visit by officials to the big RCA-Victor factory in nearby Camden, New Jersey, where they took a note of all Philadelphia license plates in the employees' parking lot and found that less than 30 per cent of the owners of these cars were paying tax, a situation which was soon corrected. (The city of Columbus, Ohio, solved a

similar problem in more dramatic fashion. Having to cope with an uncooperative factory just outside its boundaries, it annexed the land on which the factory stood and then imposed withholding requirements.) However, the number of such employees is small in relation to the total number of taxpayers and the over-all cost of collection is small, amounting to 2.3 per cent of collections, according to the most recently available figures.

It must also be noted that the success of the Philadelphia income tax has been partly due to the fact that its introduction coincided with the start of the defense boom and the consequent increase in wages and salaries was responsible for the large yield.

The successful experience of Philadelphia has encouraged other municipalities to adopt an income tax. The most extensive adoptions have been in the state of Pennsylvania itself, where in 1947 the legislature conferred broad powers on local authorities to tax any subject not taxed by the state, thus including the power to tax non-corporate income. Within the following two years over 160 local authorities availed themselves of these powers and the number has now risen to over 400. All these taxes are broadly on the lines of the Philadelphia tax, and possibly because of the lowness of the rates, no undue inconvenience appears to have been caused to those earning income in several places.

The next most numerous adoptions have come about in the neighboring state of Ohio, where the city of Toledo was the second municipality in the U.S.A. to adopt it, the rate being 1 per cent. The charge to tax was wider, extending to corporate profits derived by a corporation's having an office in Toledo "as a result of work done, services performed or rendered and business or other activities conducted in the city." (The allocation of income between sources within and without the city is calculated according to the formulas which have been successfully used in several state income tax systems.) Collections are mainly made on the Philadelphia plan, but taxpayers whose income is not wholly deducted at source pay direct on the basis of the current year's profits, making declarations of anticipated income and paying quarterly, adjusting their estimates of income as necessary. Here, too, experience has been satisfactory; costs are low (less than 3 per cent of collections) and the tax now produces about one-third of the city's revenues. Up to date, over a dozen local authorities in Ohio have levied income taxes under regulations by the state, which require special approval by the voters, prescribe the method of apportioning profits, and so on.

Outside the states of Pennsylvania and Ohio, only a handful of local authorities in Kentucky and the City of St. Louis have so far introduced income taxes, but many are considering doing so and, in any case, sufficient experience has already been obtained to justify some tentative conclusions as to the value of this new fiscal expedient and the extent to which it is likely to meet the needs of Wisconsin.

At the same time, the limited scope of the municipal income taxes must be noted, for although this does not mean that it would be impracticable to impose wider taxes, it does mean that to do so would be going beyond the bounds of present experience. The most obvious limitation is on the type of income taxed. While there has been no difficulty in extending the charge to corporate income, as is generally done outside Pennsylvania, the taxation of unearned, that is, investment income is much harder to check and make really effective. The federal government helps by making the information in its possession from its tax returns available to municipalities, and some municipalities require local returns to start off with the income reported for federal tax purposes and to show a reconciliation in detail of that figure of the income reported for local tax purposes.

The other significant feature is the adoption of a flat rate of tax. Most of the tax is paid by employees and the successful collection of the greater part of employees' tax has been due to withholding, which has in turn been largely successful because of the flat rate of tax and the consequent simplicity of calculation. Such little trouble as there has been with smaller employers suggests that collection would be substantially slower with a graduated rate of tax. The full and willing cooperation of employers is, of course, vital and it is of interest to note that the City of St. Louis has recognized the extra costs imposed upon employers by allowing them to retain 3 per cent of the tax they withhold by way of compensation for these costs.

Similarly, personal exemptions are best avoided. Of course this means that tax rates must be kept low and within the capacity of taxpayers with low incomes, which is why only one city, Philadelphia, has a rate as high as 1½ per cent and why no other city has a rate higher than 1 per cent. Some Ohio cities exempt small incomes from tax, but tax in full all incomes above the exemption limit; thus, if the exemption limit is $1,200, a person with an income of $1,200 pays no tax, while a person with an income of $1,201 pays the tax at the prescribed rate on all his income. This is administratively very convenient, but produces a relatively high marginal rate just above the exemption point, another reason for keeping the rate low.

Yet, with all its limitations, the municipal income tax has been very productive of revenue; it has added vital revenue which could otherwise have been obtained only by a crushing burden to already high property taxation. And there is every indication that once introduced it will continue to make an increasing contribution, since it is responsive to the increase in personal incomes which frequently accompanies the increase in governmental costs. Yet here again, there are limitations to be noted. In a prolonged depression incomes will fall and with them the yield in tax; but this applies to all forms of taxation, since all forms of local taxation are paid out of income, whether they are imposed on income or not, as the history of property tax delinquencies in the 1930's showed. A more serious objection is the effect on income tax yields of some variation in local prosperity and especially of such an event as a local strike. If the economy of a municipal area is largely dependent on one business unit, such as a large factory, a strike there of some duration will produce an em-

barrassing fall in local revenues. For this, and the other reasons set out above, it is clear that municipal income tax can only be a supplement to more traditional forms of local revenue, although it is a very valuable supplement.

The justice of a general income tax in itself is obvious. It is a far better measure of a person's ability to pay tax than a property tax. But this is only entirely true if all pay tax on all sources of income, and most existing municipal income taxes apply only to certain taxpayers and certain sources of income, with a consequent detraction from equity. The taxation of unearned income presents certain practical difficulties, especially when that income is from intangible assets; it is very difficult for the inevitably limited administrative staff of a municipal taxation department to check effectively the returns made by taxpayers of income from investments and the like. It is clearly more equitable that taxation should extend to the income from all forms of property, and not just to that from real property, but it is unrealistic and unjust to impose a tax covering all investment income if there is no reasonable prospect of its being adequately and uniformly collected.

A major unsolved problem of the municipal income tax is the relation between taxes imposed in contiguous districts. One of the main objectives of this tax has been to collect tax from non-residents of an area earning their living in that area. If such persons reside in an area which imposes a municipal income tax there may well be a conflict of jurisdiction as to which governmental authority shall collect the tax. If the muncipality of residence imposes its income tax on the income of all residents, those residing in one area and working in another will pay a double taxation not paid by those residing and working in the same area. The amount at stake may not be large, but the principle is important and may cause trouble. Jurisdiction based upon a taxpayer's residence makes for easier administration, but relieves the commuting suburbanite from contribution to the area of his work. It will only be rarely that a city will be given such privileges as Philadelphia, which has *exclusive* jurisdiction to tax income earned in the city by non-residents, so that other municipalities cannot tax income earned in Philadelphia by their residents.

It is important that the decision should be taken as to the basis of taxation, residence or origin of income, before any municipal income tax at all is authorized; for although the immediate intention may be for only one city to adopt such a tax, in the course of time many more may do so and the complexities of competing jurisdictions must be foreseen and provided for at the very beginning. It may be noted that the adoption of tax by one city tends to lead to the adoption by neighboring cities, especially if the tax is laid on a residence basis, for then those neighboring cities can impose the tax at little cost to their citizens in many cases, simply transferring the tax payments to themselves from the city where the income was earned. When Pittsburgh introduced an income tax in 1954, only six other authorities in the same county had that tax. Shortly afterwards the number of local taxing units in the county jumped to 73, and within nine months

there were more than 130 such units within a 25-mile radius of Pittsburgh, many of which did not need the additional revenue and must therefore be presumed to have adopted it for retaliatory purposes.

Apart from questions of double taxation and the fair apportionment of taxing jurisdiction between adjoining authorities, it must be admitted that a multiplicity of local income taxes constitutes a burden on commerce and on all those whose trade or employment covers a large area. The burden consists largely of the more complex records necessary to determine the location of the various components of income and the experience in Pennsylvania shows that it is by no means an insuperable objection.

The experience of over 400 local authorities is thus sufficient to demonstrate that —

(a) a local income tax is practicable and economical to collect;

(b) it makes an important contribution to revenue which could otherwise only be obtained by inequitable additions to existing forms of taxation — for example in Philadelphia it would require a doubling of the property tax rate to compensate for yield of the income tax and there is no reason to assume that the experience of any other major city would be widely different; but

(c) its effective use is inherently limited, so that it can only be conceived of as a supplement to existing taxes.

There is not likely to be much popular enthusiasm about the addition of a third income tax to the present federal and state income taxes and it must be admitted that most local income taxes at present exist where there is no state tax on individual incomes. Yet it may be doubted whether there would be any more substantial objection to paying three income taxes than to paying two income taxes plus a particularly burdensome type of local taxation, such as a greatly increased property tax. Further, it is easier to coordinate income taxes at various levels in order to ensure an over-all burden fairly related to ability to pay than it is to achieve equitable coordination where different levels of government impose different types of taxes.

The major problem arises where several adjoining authorities impose income taxes, as may well happen in a big industrial conurbation. (It is significant that in Sweden, the one country where the municipal income tax is universally adopted and uniformly successful, there are no such conurbations; the industrialization of the country has so far been confined to 11 compact and widely separate towns.) It would be most unwise to allow local governments to introduce income taxation as each thought fit. Past experience shows that the introduction of one local income tax tends to trigger off a series of income taxes in adjoining areas and in any case the problem of overlapping incomes has to be solved sooner or later. It is far preferable to tackle this question at the very beginning and lay down clearly the scope of the taxing powers of each governmental unit.

From the point of view of convenience, both to the administration and to the taxpayers, the tax would appear to be suitable for the larger forms of government below the state level. For example, although there does not appear to be a precedent yet for the adoption of an income tax by a county, the possibility deserves careful consideration. A county income tax does not involve the same problems as an income tax by different authorities within the county and the providing of the county with its own sources of revenue would tend to ease the burden of the city-county property tax rate (in the City of Milwaukee at present the county tax accounts for nearly one-quarter of the combined city-county rate imposed within the city). However, this and other aspects of the tax require much further examination and discussion. The local financial problem is serious and urgent; the municipal income tax provides a solution, at least a partial solution to it and it deserves consideration in the light of alternative ways of raising added revenue.

No hasty step must be taken, and if the tax is introduced, it should be done on the basis of a comprehensive and workable plan. Wisconsin was the first state to demonstrate that a state income tax would work and be productive of vital revenue when given a sound administrative basis. It may well fall to Wisconsin to show how a municipal income tax can be properly integrated into a state-local tax system adequate to the needs of the present day.

FURTHER READING

As literature on the municipal income tax is scarce, the following list may be of use to those who wish to pursue the topic further.

Robert A. Sigafoos — *The Municipal Income Tax: Its History and Problems*, (Public Administration Service, Chicago, 1955).

The only comprehensive survey of the subject. A valuable book, from which some of the illustrations in this article have been taken.

Leon J. Quinto — *Municipal Income Taxation in the United States*, (Mayor's Committee on Management Survey of the City of New York, 1952).

A useful supplement to the previous book.

Jewell C. Phillips — "Philadelphia's Income Tax After Twenty Years," *(National Tax Journal*, Vol. XI, No. 3, p. 241).

Robert H. Wessell — "Cincinnati's Income Tax — An Emergency Financing Device," *(National Tax Journal*, Vol. IX, No. 1, p. 84).

These two articles give an up-to-date survey of two of the municipal income taxes, especially from the administrative angle.

The Royal Institute of Public Administration — *New Sources of Local Revenue*, (George Allen and Unwin, London, 1956).

This book contains an appraisal of the municipal income tax as a possibility for England and also contains a very long description of that tax as actually found in Sweden.

DEEP HARBORS FOR THE SEAWAY

by

Mark J. Fitzgerald, C.S.C., Ph.D.

One stage of the Seaway timetable will be terminated this Spring when the stretch of the St. Lawrence River between Montreal and Lake Ontario becomes navigable at a depth of 27 feet. The second stage, dredging to this same depth the river channels connecting the Great Lakes, is scheduled for completion in 1962. Still undetermined is the crucial third phase of the program, recommending to Congress the particular ports on the Great Lakes which could justify the cost of lowering their harbor floors to 27 feet below lake level.

Of the present 27 federally improved harbors on the Great Lakes only three are dredged to 26 feet, and not more than 12 can boast of a depth of 25 feet. For 38 of these harbors, depths range only between 6 and 7 yards.[1] Modern lake vessels to enter minor ports in the Midwest, originally designed for the small ships of fifty years ago, must stay high in the water and thus keep idle valuable cargo space. Even most of the present major ports on the Great Lakes were planned to accommodate a maximum draft of only 22 feet, typical of the larger vessels plying these inland waters 3 decades ago.

Harbors not improved to match the depths of the Seaway and the connecting lake channels by the deadline of 1962 will receive few calls from the deep draft vessels being designed for the new era of shipping on the Great Lakes. Ocean going vessels, 4 to 5 times greater in size, will replace the small, less efficient vessels which visit our Midwestern ports today. Inevitably, the higher cost of operation for the larger ships will eliminate the practice of frequent short stops on the Great Lakes circuit. Stops will be concentrated in the major port cities where rapid cargo moving facilities will be available. Especially for the inter lake bulk traffic which may be almost 90 per cent of the total shipping,[2] harbor must match harbor in depth in order to get the desired advantage from modern deep draft vessels.

To determine which harbors shall be further improved at federal expense to match the Seaway depth of 27 feet, Congress in 1956 assigned to the Army Corps of Engineers the monumental task of preparing the Great Lakes Harbors Survey involving traffic analysis, engineering studies, and economic justification. For over two years now a transportation office of the Corps of Engineers has been on re-

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1. "The Seaway and Its Meaning to Our Area," 3-11-58 (mimeographed), Edwin W. Nelson, Chief Engineering Consultant, North Central Division, Corps of Engineers, p. 5.

2. Interview with Arthur H. Schwietert, Director of the Transportation Division of the Chicago Association of Commerce and Industry.

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search to assay prospective commerce to and from the various harbors on the Lakes, the type of vessels which will carry it, and the probability that savings in traffic charges will warrant the cost of dredging the harbors under consideration.

To estimate the potential flow of both domestic and international cargo traffic, a comprehensive report by questionnaire and interview is being prepared of manufacturing, mining, farming and marketing in the Great Lakes area and its tributary states. A separate phase in the same analysis is the origin-destination study of overseas general cargo traffic, as apart from bulk cargo, being assembled for the Corps of Engineers by the Bureau of the Census.

This latter project will bring to light the first collection of tangible information on overseas general cargo traffic originating or ending in the Midwest since regular service began 25 years ago. Taking 1956 as the base year the Bureau has traced back by use of shipping documents and questionnaires, 8000 specific import items for 1956 carefully chosen by categories, and a like number of export items.[3] It is now known where this general cargo originated, the water and land transportation used en route, and the ocean and lake ports, if any, which handled the shipments.

With this data at hand the Corps of Engineers has been able to determine the actual shipping expense for each item, including the cost of overland transportation to or from any port used in this country. Then assuming that the Seaway of 1962 had been a possible alternative route in 1956, the Corps for each of the export and import items traced by the Bureau of the Census has worked out the logical Seaway routing by most probable Great Lakes port. The cost figures are now being compared for overseas shipping with and without travel by the Seaway.

By blowing up the sample to represent total export-import movement of overseas general cargo in 1956, and projecting the figures for fifty years ahead, the Corps of Engineers will have an economic basis to determine which harbors warrant the cost of improving them to match Seaway depths. Like all engineering projects referred by Congress to the Corps for economic feasibility, the Great Lakes harbor improvements will be expected to pay back the federal outlay in savings for inter-lake and overseas traffic, over a period of fifty years.

In terms of bulk cargo, the Department of Agriculture is also making an economic cost study for the Corps of Engineers in regard to grain shipments from west of Chicago to foreign buyers. All possible routings, by Atlantic, Pacific, Gulf and Lakeports now and in 1962, are being compared as to transport cost. Moreover, the Department of Agriculture even notes the lowest possible rates the railroads might use in the future to meet Seaway competition, namely, bare out-of-pocket expense involved in hauling the grain by rail from

3. Interview with W. G. McLennan, Transportation Economist, North Central Division, Corps of Engineers, U. S. Army, Chicago.

the Midwest to an ocean port. Likely the railroads will hesitate to use such profitless rates because of present deficits and the enormous area over which they would have to be applied to counteract the Seaway. To predict the future economic advantage of the Seaway as it relates to lead, copper, bauxite, sulphur and petroleum, the Corps is using an economic analysis compiled by the Bureau of Mines.[4]

It will be the task of the Corps of Engineers to correlate the findings of all the government agencies assisting in the traffic study and then recommend to Congress which and how many Great Lakes harbors warrant a depth of 27 feet. After first estimating the entire volume of cargo traffic, domestic and foreign, that could be shipped economically on the Lakes to or from the eight bordering states and 11 hinterland states, the Corps will then break down the total according to the particular harbors regarded as logical ports of entry or exit. For any one harbor, if over a period of fifty years the ratio of economic advantage to the annual cost of amortization is substantially more than 1 to 1, the Corps will recommend that harbor for the 27 foot depth. By early 1959 these computations may be finished and the long anticipated Great Lakes Harbor Survey will then receive consideration by Congress.[5]

Very likely at the start only the major parts, a small number of the 57 harbors on the Great Lakes, will be given authorization for the standard Seaway depth. Other factors besides saving in distance may enter into the final decision. Adequate warehouse and cargo handling facilities may weigh heavily. Unfortunately some lake cities have built so closely to the water's edge, that there is little space available for modern harbor development free of traffic congestion. All such circumstances should have their influence in shaping the pattern of future cargo shipments on the Great Lakes.

With huge investments in piers and warehouses already underway in a number of major port cities, it is obvious that federal appropriations are expected to finance the lowering of the harbor floors in those ports to the depth of 27 feet. Milwaukee, a close shipping rival to Chicago, has 14 berths for modern lake vessels in her municipal harbor, and is currently spending $12 million for 11 additional berths. Duluth, unrivaled for ore and grain shipments, is expending $10 million of state and city funds to enlarge its port facilities. Cleveland, which will not have to wait to welcome deep draft vessels from the Seaway until river channels are lowered further west, has appropriated $5 million for two additional cargo piers. For the present, Detroit, though much nearer to the Atlantic than Milwaukee or Chicago, is checked on port development because the voters both in 1957 and in 1958 rejected a proposed $9.5 million bond issue for the purpose.

Of all the port cities, Chicago anticipates the greatest benefit from the deepened Seaway. Already handling 40 per cent of overseas

4. "Progress on Deepening the Great Lakes Connecting Channels and Preparation of the Comprehensive Great Lakes Harbors Survey Report," 11-12-57 (mimeographed), Edwin W. Nelson, p. 14.

5. "The Seaway and Its Meaning to our Area," *op. cit.*, p. 15.

tonnage entering the Great Lakes and a port of call for 90 per cent of the European vessels visiting the Midwest, Chicago's plans for port development far exceed her sister cities on the Lakes. In addition to present and future piers on Lake Michigan, Lake Calumet, six miles away, is being converted into an artificial harbor with over 25 vessel berths. They will be serviced for ships, barges, railroads and trucks by completely integrated loading and warehouse facilities. Locked into adjacent motor expressways by two cloverleafs, Calumet harbor, unlike most lake ports, will operate free of city traffic congestion. This harbor is uniquely situated to attract cargo to and from the Seaway since it is connected by water to both the Mississippi River and the Great Lakes. Impressed with the future importance of Calumet Harbor, the federal government plans to spend over $100 million to deepen and vastly widen Calumet Channel which links this harbor with the Mississippi River system.

There is considerable basis for the belief that growth of traffic on the new Seaway at the start will be gradual rather than spectacular. It will take time to overcome a number of troublesome obstacles. One is resistance to change on the part of veteran traffic managers who have developed life long connections with shipping lines operating out of Atlantic ports. Full utilization of the Seaway cannot be expected until many potential users have been educated to the economic advantage offered by this overseas route. Further, such advantage will not be available to all until shipping service becomes more frequent and regular than in the past. Again, there will be considerable time before the established world wide export banking arrangements, awaiting an American shipper when he uses New York harbor or other Atlantic ports, can be duplicated with routing through the Seaway. At present the shipper who exports through a major Lake port can expect good banking services for the European mainland, the Mediterranean area, and Scandinavia, but not beyond those regions.

Inevitably, however, the substantial savings in freight cost from the use of Lake ports will finally have their impact and the volume of overseas traffic by Seaway will then expand greatly. Even with the present small vessels and the shallow draft channels which restrict cargo loads, overseas tonnage through the Seaway into Lake Michigan has mounted over 9 fold from 1947 to 1956.[6] More diversion to the Lake ports will follow on a bigger scale when it becomes possible to ship in large quantities overseas from Cleveland, for example, and thus cut by one-half the "dollar distance" from that city to Liverpool. More advantage than now will be taken in the target year 1962 of a freight rate for automobiles, from Chicago to Rotterdam through the St. Lawrence, which is 17 per cent less than over railroads to vessels sailing from Atlantic ports. With the Great Lakes region continuing to expand as the industrial heart of the nation, sound economic realism will not permit shippers to and from that area, when the coming deep harbors beckon for cargo, to ignore for long the obvious savings offered by the Seaway.

6. "The Coming Battle of the St. Lawrence Seaway," Marvin J. Bartoon, *Harper's Magazine*, September, 1957, p. 31.

AN ECONOMIC HISTORY OF THE AMERICAN OIL INDUSTRY, 1859-1959

by

Neil P. Hurley, S.J.

EDITOR'S NOTE: This summer the American oil industry will commemorate its centennial anniversary. In anticipation of numerous articles on the influence of petroleum in our economy, we are taking this opportunity to give you one of the best treatments of the economic history of the oil industry in this country.

The author is Neil P. Hurley, S.J., who received his Degree in Economics from Fordham University and who is now at the Jesuitenkolleg in Innsbruck, Austria. In this issue he discusses the production, refining and marketing of petroleum up to the great depression; the June issue will contain his analysis of the industry's last thirty years.

With its physical origins in the twilight of time, oil has proved relevant in human history only in very recent times. We know that the Spaniards used it as early as 1543 to smear on the bottoms of their ships and that the Indians used the viscous subterranean mineral to preserve ceremonial fires, to barter with, and for medicinal purposes. The real commercial value, however, of petroleum goes back to the middle of the nineteenth century when the search for a cheap, practicable illuminant led men like James Young of Glasgow to extract a crude liquid hydrocarbon from coal and shale. The first oil company in the United States antedates, paradoxically enough, the official birthday of the nation's oil industry. George H. Bissell and J. G. Eveleth formed the Pennsylvania Rock Oil Company in 1855, four years before Edwin L. Drake and "Uncle Billy" Smith sank their stovepipe casing in a field above Titusville, Pennsylvania to become the first prospectors to find oil by drilling for it. The Pennsylvania Rock Oil Company had recovered its oil up to that time from seepages on its land.

However, the intense "oil fever" that followed upon the Titusville event was not restricted to Pennsylvania. Texas had oil seeps and springs and was trying to find oil by a spring pole rig as early as 1859. Nonetheless Texas had to wait seven years before it boasted of its first successfully drilled well. As one might readily expect, speculators and wildcatters began to flock into both states to seek their fortunes.

The industry, with limited oil findings in Oklahoma, Kansas, Texas and California during the Civil War period, was in its incubation period. The following pages treat the economic progression of the industry from infancy to manhood. In covering the first hundred years of growth of the American oil industry we will break down our chronicle into decades and discuss only the salient achievements in the five phases of oil operation: exploration, production, refining, transportation, and marketing.

The Industry from 1860 to 1870:

This decade concerns oil production in Texas, California and Pennsylvania. The lack of adequate financing and sound management inhibited the proper development of the rich resources in other states such as Oklahoma and Kansas. That the infant industry was growing rapidly can be seen by the statistical fact that annual production rose from 2,000 barrels in 1859 to 4,800,000 by 1870. By this date it is possible to discern the five distinct stages which characterize the oil industry today: exploration, production, refining, transporting and marketing. None of these stages was at any refined point of scientific development. Oil prospecting was a matter of hunches, divining rods, and following down rumors about oil seepages. Drilling methods were very crude. In cable tool drilling a heavy steel bit and stem at the end of a cable were raised and dropped rhythmically in order to punch through rock strata. The rotary drilling, while superior to cable tool drilling, had to await further refinements. A continuous column of steel bit was rapidly rotated and progressively lengthened as the hole deepened. The cuttings were then displaced by forcing mud down through the hollow of the drill pipe. California took credit in this period for introducing the steam rig: a bull wheel which rocked the beams that raised and lowered the heavy bits. As compared with the earlier spring pole method whereby men would hop on and off the treadles connected to the spring pole driving the bits, this method was far superior and enabled production to be quadrupled.

Refining methods consisted of distilling equipment borrowed from coal oil and linseed oil producers. Refineries were crude stills in which impurities were boiled off and the lower boiling fractions were separated out by condensation. End-products yields were low, ranging from 25 per cent to 40 per cent.

The main means of transportation as of 1870 were wagons, barges, sailing ships and steamers. In the 1860's short-distance pipelines and artificial freshets were established so that flat boats and barges could reach the oil fields in the Venango Valley, Pennsylvania. The first pipeline, built in 1865, was 5 miles long. By 1874, it ran from Pithole City, Pennsylvania, to Pittsburgh, a distance of 60 miles. A barge at this time carried from 1,000 to 3,000 barrels of oil with transfers being made to steamboats and later to railroad tank cars.

As for marketing procedures, kerosene and lubricating oils were sold through local grocery and hardware stores, while door-to-door deliveries were made with horse-drawn tank wagons in milkman fashion. Kerosene was delivered in containers and the empties were later picked up. Since the fuel oil period would not be ushered onto the American scene until 1900, those engaged in oil operations concentrated on production and refining techniques with little concern for the later stages of distribution and marketing.

The decade 1860-1870 was one of risk and speculation; "oil is where you find it" was the watchword and only one hole out of every nine proved successful. Petroleum enterprisers of the period,

unaware of the energy potential in their product, restricted end-uses to such purposes as medicine, lubrication and illumination.

The Industry in 1870-1880:

As of 1880 three states had a sizeable share of the world's entire oil production: Ohio, West Virginia and Pennsylvania. At relatively great distances from the heavy-populated metropolitan areas of the East, other rich oil regions in California, Kansas, Oklahoma and Texas suffered a transportation-cost disadvantage which only time would efface. Besides, these states sorely needed drillers with sufficient capital resources and equipment to bring to the surface the pools of crude and then to refine them. With the eventual growth of the hinterland areas in the Southwest and the Far West, adequate transport arteries and greater market demands attracted larger oil investments.

Obviously the short-run view prevailed in the early wildcatting stage of American oil production. In a field where competition was sharp and individualism rife, wasteful extractive methods were bound to arise. Homestead land was easy to stake out. In addition to the scramble for leases and titles was the problem of subsurface rights. Attempts to bleed pools which ran under various properties were difficult to control in this decade. Dabbling in oil leases also became quite common, with cash bonuses paid at the time of the lease plus a rental until drilling operations began. It often happened that young promoters with slender resources lost leases on oil-producing properties. Those companies fared well which could afford the most up-to-date "hardware" (drilling tools, casings, refining furnaces, steam-drilling engines).

Despite the prodigality of spectacular gushers and such cave-man techniques as hand-dug wells and the "stomping down" methods of the spring-pole rig, the era witnessed the widespread use of the rotary bit and steam drilling, thus producing wells with unprecedented depths of 1,500 feet to 2,000 feet. "Directional drilling," so common today in off-shore drilling, was then known in principle. In 1866 Josiah Stanford, brother of the famous railroad builder, adapted this mining technique to oil removal. Digging a tunnel of 80 feet into the south slope of a mountain with oil seepages, he was able to tap an oil snag formation some 16 miles long and thus draw up 20 barrels a day. Grading the floor to enable the oil to flow out by gravity into tanks near the entrance eliminated waste and held removal costs to a minimum.

In the area of refining, it became evident that some crude oil hydrocarbons were unstable under conditions of continuous heating. This knowledge, which would later lead to the revolutionary Burton thermal cracking process, was not yet utilized. Distillation was the common method of separating out petroleum products. Crude oil was vaporized in a still, then cooled and allowed to condense into liquids. However gasoline and lubricant distillates, so important today, were ignored and producers sought profit in those fractions that could be made into kerosene or lubricants.

Water travel was the popular method of transporting oil in this decade. Barges navigated deep-water channels in the Gulf Coast area, along the Mississippi River and the Ohio River. Tanks were installed in the hulls of sailing ships and schooners to permit volume loading and lower unit costs. Tanker and barge operations were advantageous insofar as they allowed greater flexibility in scheduling shipments according to demand. Rail transportation was also popular, especially after the development of the horizontal tank car in the mid-1870's. Pipelines had limited use; those in existence worked on a gravity-feed principle, being sloped for short distances to obviate the need for pumping stations. Paucity of demand in the Gulf Coast and the Pacific Coast areas was the reason that pipeline arteries were virtually unknown there. In 1879 the first major pipeline in the nation was completed and extended 110 miles from Coryville, in western Pennsylvania, across the Alleghany Mountains to Williamsport, Pennsylvania.

As long as bulk plant operations, large scale refinery runs and new uses of petroleum were not realities in the American oil industry, marketing operations would always be dominated by local retailers. This was definitely the case in oil distribution in the period from 1870-1880.

The period is significant for the attempts made to curtail and eliminate abuses in oil operations. As early as February, 1869 the Petroleum Producers' Association of Pennsylvania had been formed to curb monopoly groups, to oppose unfavorable state legislative proposals, and to issue monthly statistics on production. Now with violent vacillations in prices for refined oil products, a noticeable trend toward merger and consolidation arose as part of a conscious strategy to stabilize costs. On January 10, 1870 the Standard Oil Company (Ohio) was formed with John D. Rockefeller as President. The facilities of the new company consisted mainly of two large refineries in Cleveland. The step was the first one toward horizontal integration at the refining level and the beginning of a deep-seated vertically integrated structure which would culminate in the anti-trust decision of the Supreme Court in 1913. By 1881 the Standard Oil Company alliance had incorporated into its organization a large segment of the U. S. oil industry. With the acquisition of significant shareholdings in firms owning pipelines, refineries, and domestic marketing outlets, the industry took on unmistakable colorings.

The Oil Industry from 1880 to 1900:

This period saw the entrenchment of one company, the Standard Oil Company (Ohio), as the major oil operator in the United States. It was in this period, too, that the oil fields in the Southwest and Pacific Coast regions began serious competition with Eastern producers. The corporate form of business grew increasingly more popular as the most apt way to amass the large sums of venture capital needed to maintain the oil needs of a rapidly expanding society. Rockefeller's preoccupation with eliminating waste and maximizing profits by economies at every stage of the oil business led to unre-

stricted competitive measures and a strategy of complete integration backward and forward. This led subsequently to exposés such as that of Ida B. Tarbell and others of the so-called "muck-raking school."

In order to appreciate fully the dimensions of the mushroom growth which characterized the industry from 1880-1900, an examination must be made of the salient facts concerning the Standard Oil trust. The company's top management was centralized in a New York office, while the Ohio unit was divested of its out-of-state properties to avoid heavy tax burdens. Then special corporations were set up to hold Standard Oil properties in each state. The Trust Agreement, signed by 41 investors on January 2, 1882, involved properties whose total value was $70 million. Jersey Standard and New York Standard were thus created as well as other companies. Such a vast corporate organization could only be properly managed by committees which coordinated, standardized and integrated the activities of all the sister companies. The committee system, with its centralized staff in New York City, became a firmly established ingredient of Standard Oil's business policy and exercised a decisive influence on the shape of America's future industrial society.

Standard Oil rode out the wave of instability which broke in the 1870's by such policies as centralized purchasing, development of new by-products and consequently new markets, the concentration of production in a few large scale plants, and the slashing of freight rates by virtue of volume business. Consequent upon such tactics and upon the vertical integration of crude oil gathering operations, pipelines and bulk plants, was the improvement of quality and service. Standard initiated overseas operations and soon gave the United States supremacy over Russia and other foreign nations in the sale of oil. Standard's size also enabled chemical research and laboratory experimentation as, for instance, in the case of the company development of the Frash process to vaporize the ill-smelling sulphur which was found mixed in with the petroleum in its Lima, Indiana territory. Marketing research was also an innovation of the period and, by means of it, Standard stressed the use of industrial fuels and showed how economical oil burners were for many industries such as steel and brass.

Also burgeoning in this period were the hitherto dormant oil interests in the Southwest and Pacific Coast regions. Texas gained significance in 1894 with the fortuitous, rich strike at Corsicana by three men prospecting for water. By 1898 Texas produced 546,000 barrels of oil, an increase of 480,000 barrels over the previous year. The industry in California experienced a similar Topsy-like growth. As of 1880 the state's production, derived mainly from the districts of Ventura, Los Angeles and Santa Barbara, was a meager 40,500 barrels. This figure soared to over 20 million barrels by 1900. The story of California oil during this period is closely bound up with the Union Oil Company, whose first significant competitor did not appear till 1899. The product of a merger of four smaller companies in 1890, Union Oil Company laid pipelines, built transport vessels, and sought to develop a local oil market for fuel purposes. Apart from

West Virginia, whose production as of 1900 was 16 million barrels, other states such as Kentucky, Tennessee, Missouri and Kansas had to await the coming of the twentieth century before winning their laurels as significant oil-producing states.

Technological advances abounded in the *fin de siècle* period. Oil wells were cemented to keep water out. Fewer horses were seen walking around "sweeps"; instead one saw steam rigs and rotary drills with an average of 20 to 30 horsepower capacity. Standard Oil's Whiting, Indiana refinery was the last word in continuous flow processes as compared with the cruder distilleries of California and Texas, with their time-consuming batch processes geared more for kerosene production. The existence of the Whiting refinery constituted a serious threat to California oil producers, since pipelines conveyed oil from Whiting to Chicago. Naturally the competitive advantage of Standard, resulting in freight differentials, rebates and kick-backs, was the main reason that the company could make a strong competitive bid for the markets of the West Coast. Moreover the Standard Oil Company availed itself of box tank cars which could return from the West with bullion and valuable ores and also of steel barges instead of the slower, less competitive wooden "pig" barges of an earlier period.

Pipeline construction improved considerably in this period. Larger pumps were installed in pump stations and forced oil over steeper grades and into remoter regions. The average diameter of a pipeline was from 4 to 8 inches. Companies became more accurate in inventory control, using temperature readings, since oil expands in hot weather. Disaster control and safety precautions become more widespread; for example, the storage tanks at the Whiting refinery were spaced at 500 feet intervals with a fire bank about each tank.

Just as the West and Southwest lagged behind the practices of the Midwest and the East regarding refining, transportation, chemical research, finance and organization so, too, distribution and marketing procedures were more highly developed in the latter regions than in the former. Thus, big firms hired draymen to make deliveries of oil (the company supplied the tank wagon and the agent furnished the horses). Plants were strategically situated at 12 mile intervals so that a team of horses could reach the plant within a day. In the West distribution often took place with 24-mule teams which hauled asphaltum, liquid and solid, from the source to the consumer. Kerosene was the largest selling oil product, with gasoline as a by-product with highly restricted uses. Direct marketing facilities spread within the Standard empire, gradually eliminating the jobber. In addition, advertising techniques were resorted to; for example, Standard called the public's attention to the diversified uses of its lighter oils.

The Industry from 1900 to 1910:

This era began with a dramatic curtain-raiser. At 10:30 A. M. on January 10, 1901 outside of Beaumont, Texas, gas rumbled out of its prehistoric cradle on a hillock called Spindletop. The heavy oil which

accompanied it spouted some 200 feet into the air. The appearance of the country's greatest gusher to date established a bench mark in the oil industry's history. Previous to Spindletop, the nation's 58 million barrels of oil came mostly from the East, in and around Pennsylvania. Of this Standard controlled some 80 per cent of production. With Spindletop the industry not only grew significantly but it became amazingly competitive. Large scale companies such as Texaco Company and the Gulf Company were to be subsequently formed, making inroads on Standard Oil's monopolistic position. That first well at Spindletop alone produced as much oil as 37,000 Eastern wells combined, and by early 1902 its 138 wells matched the production of the rest of the world.

As soon as Standard Oil heard the incredible news of a well flowing at the rate of 75,000 to 100,000 barrels a day, it marked down its price for Pennsylvania oil. In May, 1901 the Pittsburgh banking house of Mellon & Sons financed the organization of the J. M. Guffey Petroleum Corporation with a capitalization of $15 million. This company, later to be known as the Gulf Oil Company, operated Spindletop and other oil leases in Texas and Louisiana.

While speculators flocked to Texas, the price of crude fluctuated violently from 10 cents a barrel to half a dollar and back. Texas oil was once as low as 5 cents a barrel. It was the Gulf Refining Company of Texas, formed on November 10, 1901, which sought to stabilize the volatile market. Its chief problem was "sweetening" the sour oil of Texas which was viscous, heavy with sulphur, and had an asphalt base, as contrasted with "sweet" Pennsylvania oil, which was free from sulphur and had a paraffin base. Specially designed stills and de-sulphurizing units were designed by petroleum chemists and engineers in order to render Texas crude acceptable to the British Navy, which at the time powered its craft with oil.

The Texas Company joined Gulf Oil in contesting the supremacy of Standard Oil in the American petroleum industry. Founded in 1902 as the Texas Fuel Company, this firm started with an authorized capital of $50,000 and grew steadily. Spindletop also resulted in the formation of the Sun Oil Company's Texas branch. Mainly an operator in the Middle Atlantic States and in the Mid-west since the 1890's, the Sun Oil Company shipped oil to Port Arthur by a competitor's pipeline and from there by vessel to Philadelphia for refining. It soon became a major operator.

On the other hand, the Standard Oil Company complex purposely limited its activity in the Texas area. Anti-trust statutes were severe in Texas, and Standard's subsidiaries had already experienced difficulties there. Besides the unfavorable legal climate, there was the fact that, despite Spindletop's fabulous return, other states showed promising "flush production" records. The crude from Oklahoma and Kansas was richer in kerosene and gasoline yields than that of Texas and the total flow of oil from these regions was, on balance, steadier than that of Texas.

Oklahoma's production sensation in this decade was the Glenn Pool oil discovery; of the 125 wells which it owned in the region, the Prairie Oil & Gas Company boasted 102 successful wells. The crude was high grade, "sweet" and had a paraffin base. It could be gotten from relatively shallow wells which meant moderate drilling costs. As of September, 1907, Glenn Pool oil filled the pipelines of Standard Oil, Gulf and the Texas Company with 27,050,000 barrels. Only the Baku oil fields of southeastern Russia could claim a more astonishing record. Naturally, the Southwest swiftly moved into the vanguard of oil production as a result of the Spindletop and Glenn Pool discoveries. Spindletop alone had raised up 609 oil firms, and in the year 1901 this one field produced one-sixth of the world's crude oil.

Louisiana also experienced oil prosperity, if to a lesser degree. The Caddo Parish field in northwestern Louisiana yielded a steady flow of oil and gas. By 1909 Caddo produced 1,028,818 barrels of oil and in 1910, 5,090,793 barrels. Kansas oil swelled the nation's supplies. In 1900 it produced 77,714 barrels; by 1903 this figure reached 932,214 barrels. With its refinery at Neodesha, Kansas, Standard cut freight costs and offered keen competition to Sun Oil, the Texas Company and Gulf Refining. In time the "sweet" oil of Kansas and Oklahoma displaced the "sour" Lima crude as the basic stock for the Whiting refinery.

Standard, in the meanwhile, consolidated its competitive position on the coast by purchasing the Pacific Coast Company, supposedly the oldest company in continuous operation in the West. The oil giant also secured preferential freight rates from Western railroads and thus could market refined products on the Pacific Coast at favorable prices. Standard's move into California was fraught with economic significance, since it involved pipeline construction, storage tank building, and the development of refineries and markets to constitute an integrated operation. This acted as a spur to local producers to develop their productive capacity so as not to cede competitive advantages to eastern rivals. At this time, Wyoming joined California as a western oil producing state.

Undoubtedly the greatest single factor in catalyzing oil development in this decade was the introduction of the automobile. The benzine-powered buggy, which inventors such as Duryea, Haynes and Selden realized, caused the stepchildren of the oil industry, the heavy bottom oils, to be the subject of greater demand. Auto registration went from 8,000 in 1900 to 500,000 in 1910. Companies naturally began to concentrate on the growing fuel gas market.

In this decade all petroleum refiners outside of the Standard Oil group formed a voluntary organization, called the National Petroleum Association. Their objective was "the necessity of mutual aid to avoid extermination."

As for technical development and maturing of the industry in this period, one noticed that the "hit and miss" technique of striking a lucky "pay streak" was disappearing. Instead of doodle-bugs and

divining rods, scientific measures were resorted to: the careful analysis of faults, dips and outcropping which could reveal oil-trapping rock structures. The Union Oil Company in California kept logs of drilled wells and took foot-by-foot samples of punched holes. Earth could be microscoped to determine when the drill would encounter coarse or fine sand, clay, shale, limestone or conglomerate material. It was found that fossil fish scales, marine life, wood fragments and vegetable growth bore valuable tell-tale information. Micro-paleontology, the study of microscopic fossils found in rock borings, grew as a science and helped oil firms to decide whether a site should be "spudded in" or not.

Fishtail rotary bits and two-cone rotary bits made drilling depths of 2000 feet possible. The Glenn Pool findings, the Spindletop gusher, and discoveries in the San Joaquin Valley of Lower California gave impetus to technological advances in general. Pipelines mushroomed. By January, 1902 three pipelines had been completed, two from Beaumont to Port Arthur, Texas, 19 miles away, and another to Sabine, 24 miles away. Storage facilities shot up near the Southwest oilfields and the newly formed companies of Texas Company, the Gulf Refining and the Sun Oil established pipeline terminals in the area. In the California area both Standard Oil and Union Oil built pipelines from the south, where oil production was heavy, to the north, where consumption was greatest. The Associated Oil Company introduced the rifled pipeline which had spiral borings much like the bore of a rifle. This internal twist kept the precious fluid whirling forward. Tanker fleets and railroad tank cars continued to serve in the transportation of oil.

As was to be expected, the over-production of oil in Texas, the Mid-Continent area, Indiana and California kicked off major sales programs. The internal combustion engine had not yet been refined to such a degree that the excess oil output of the 1900-1910 decade could be readily absorbed. The major end products were asphalt for roads and roofing purposes, oil for heating and generating steam, lubricating oils, greases, wax, candles, and acid sludges.

Refining techniques were improved by means of quality control and market research. In addition least-cost locations in the competitive field of refining were sought out on the basis of thoroughgoing considerations by management. No longer was proximity to producing wells the important factor it once was. Transport costs on finished products, as well as purchasing costs of supplies, were equally important determining factors. Consumers were concentrated in fixed metropolitan markets, whereas oil fields changed rapidly according to length of yield and the comparative advantages of other petroleum sources. A compromise location for refineries was frequently the result: a site would be chosen which was the resolution of various vector forces such as transport costs of crude, shipping costs of refined products, the available supply of labor, and water and energy. Scientific management and strategic plant location in the oil industry became an integral part of doing business.

The Industry from 1910 to 1920:

The American oil industry in this period underwent a phase of growing pains which is rather typical of most industries at an adolescent stage of development. As demand for the product increases, the problems which once baffled the industry's pioneers are gradually solved. Appropriate skills and techniques are hit upon, refined, and passed on from generation to generation. Venture capital is less scarce, as a rule, for such maturing industries than for infant ones. Research and product design are thus facilitated. Many uncertainties of processing and marketing are eliminated and larger production units appear to create a demand for pools of semi-skilled and skilled labor, for energy sources and for adequate mass transportation facilities. These multiplier effects stimulate the national economy and in turn allow the growth of interrelated industries to act as a catalytic agent on the industry. This was certainly the broad picture of American petroleum at the time of World War I.

Jersey Standard's large scale operations, which led to huge economies and volume sales, also precipitated public fears of monopolistic control. This led in turn to unfavorable publicity and reaction. Antitrust suits against Standard Oil subsidiaries were pressed in Missouri, Texas, Kansas and Tennessee. The Court held, in the dissolution suit in 1909, that seven representatives of Jersey Standard and thirty-seven subsidiary corporations had entered into an illegal conspiracy in restraint of trade and had secured an illegal monopoly of a substantial part of interstate and international commerce in petroleum and its products. As a result thirty-three subsidiaries were to be separated from control of the parent company.

The year 1909 is a benchmark year in the history of the American oil industry for more than one reason. First of all, the modern assembly line technique was introduced by Ford in that year. The basic concepts of standardization and interchangeability pushed Ford production in 1913 to a daily figure of 1,000 cars. This prolific production record had important "trigger effects" on the oil industry, inasmuch as the internal combustion engine required a fuel that evaporated at a relatively low temperature, had a high heat value, burned without objectionable residues and without pungent odors, which was also low-priced and capable of being produced in great quantity.

Another major achievement in 1913 was the discovery of the Burton thermal cracking process which "cracked" relatively valueless residues into a gasoline product with anti-knock qualities superior to that obtained in the ordinary distillation process. A third major achievement was the plethora of new wells discovered at the time. The Cushing field gave Oklahoma primacy among the states in oil production; as of January, 1913, this single field produced 11,000 barrels daily and within a month 20,000 barrels a day. New "pay streaks" were progressively discovered with greater depths until a new daily peak of 330,000 barrels a day was reached in April, 1915. In August, 1913 another Oklahoma bonanza at Healdton was discovered.

Significant in this decade are the conservation methods which were introduced. American and Canadian courts had ruled earlier that landowners could withdraw as much oil as they liked from a common reservoir, regardless of the effect on one's neighbors. This ruling, together with the tendency of lessees to exploit lands in quick time, led to proration based on the principle of "ratable taking." This device allowed each operator in a field to produce only a stipulated percentage of the oil his wells were capable of producing. Regulatory bodies in each state were empowered to enforce the "ratable taking" by penalizing those who exceeded fixed quotas.

The popularity of the automobile was nothing short of spectacular in this decade. By 1920 there were 9,239,161 motor vehicles registered in the nation as contrasted with the 468,500 registrations in 1910. The large companies erected bulk plants near significant urban centers to service vehicle owners. Besides, company-owned and operated drive-in service stations were established. Also the oil companies sought to lease privately-built stations and marketed their petroleum products through these retail channels as well. By 1920 there were some 15,000 service stations to handle the needs of the more than 9.2 million cars on the road. Demand for fuel oil rose in direct proportion with the increase in farm mechanization and the use of tanks, planes, battleships and railroad trains. Gas engines were also used in boats, grain elevators, water pumps, washing machines, churns, cider presses, and in machines for baling hay and sawing wood. The war effort of 1917 expanded the fuel oil market even further because of the widespread use of portable and stationary engines at military bases.

Despite the "flush production" of the period and the sudden increase in demand, a critical gasoline shortage arose in the United States in 1915. This was primarily due to the production decline at the Cushing field and the curtailed drilling operations which accompanied the general depression of prices in the oil business at the time. The shortage reasserted itself in the 1917-1918 period. Consequently a Committee on Petroleum was formed in 1917 by the Advisory Commission of the Council of National Defense. Together with a voluntary industry organization called the Petroleum War Service Committee of the U. S. Chamber of Commerce, it encouraged exploration and drilling. The shortage was alleviated by the new rich arteries discovered in the Ranger and Burkburnett areas of Texas. Boom-towns appeared where sparsely-populated villages had once been. As a result Texas' oil production reached 79,366,000 barrels in 1919. Nevertheless California was still the leading oil-producing state, with fertile geologic basins in the Los Angeles area and the San Joaquin Valley.

To known exploration methods was added surface geological mapping. This new technique was first tried at the Cushing Pool in 1912, later at the Newkirk Pool in Oklahoma in 1913, and subsequently at the El Dorado and Augusta Pools in Kansas in 1916. Aerial photography enabled geologists to determine the quality of the subsurface formations merely from the upward thrusts of the terrain and rock.

Seismic measurement was also introduced. With this method geophysical survey crews, using geophones and detectors to record impulses caused by dynamiting, correlated the intensity of the waves set in motion and the intervals required for them to travel down till they struck rock and refracted upward. This information was valuable in oil prospecting predictions.

The existence of a supplier's market from 1915 to 1919 led to a scramble for oil leases. Standard Oil particularly had to seek oil properties since the 1911 dissolution decree had stripped it of the ones it had had. Jersey Standard logically started a drive for backward vertical integration by purchasing earlier stages of production. Other companies which pursued a marked backward integration policy were the Atlantic Refining Company, Ohio Standard, Gulf Oil, the Texas Company, and the California Oil Company. The advantage in such a move lies in the fact that refinery operations, which required huge capital investments, were dependent upon large crude inventories to insure continuous operation and to prevent margin squeezes on profits which might arise from fluctuations in crude prices at the well-head.

The stimulus of keen competition prompted the leading oil companies to improve production methods also. The cable tool method became obsolete as rotary drills reached the unprecedented depth of one mile. The "gas-lift" was a monumental innovation. Here gas was pumped into the hole under pressure, forcing the oil up the tubing and preventing the settling of "lazy oil" in natural vaults. Other secondary yield methods at the time were repressuring the reservoirs with gas or air.

A change in transportation was noted inasmuch as pipeline service for the first time superseded water-borne oil cargo carrying. This was due to the threat of German submarines to coastwise shipping. In addition, the larger companies were integrating vertically by acquiring and/or establishing pipeline facilities. Sufficient volume would make oil delivery decidedly cheaper by pipeline as against trucking and rail services. It was during this decade, consequently, that the pipeline network as we know it today was established in its basic outline. Oil geography and plant location decisions were profoundly affected by pipeline construction. By veining the richest oil territories and connecting the production sources with refining centers, pipelines enabled processing plants and refineries to locate near densely-populated areas, distant from raw material sources. Besides, pipelines eliminated the two-way traffic problem and saved 50 per cent of the freight rates which railroads charged. The usual procedure for defraying the vast capital expenditures which pipelines necessitated was a joint enterprise of two or more companies.

In the refining field concentration of refineries was realized in and about large metropolitan areas such as Bayonne, New Jersey; Philadelphia, Pennsylvania; Port Arthur, Texas; and Kansas City, Missouri. Small refineries arose as marginal producers during the gasoline shortage from 1915 to 1919 and took advantage of the high gas prices by skimming off gas fractions and neglecting by-products and heavy bottoms. Cross-licensing among oil companies became quite

common. Mutual advantages could often be secured by companies which did not stand in direct competition with one another.

The Burton thermal cracking process gave 50 per cent richer gasoline yields. The earlier method of horizontal distillation gave way to the vertical still or fractionating tower. The former method was a batch process whereby time constants were necessarily large because of the transfer of material and the delay in waiting for these materials to be heated up. The new method eliminated this and insured maximum heat utilization.

Petrochemicals, an industry in itself today, was slowly starting up in the period from 1910-1920. The first petrochemical feedstocks were ethylene and propylene. Jersey Standard was producing alcohols from petroleum fractions as early as 1919. In the following decades petroleum would become the base of the chemical and synthetic rubber industry.

The popularity of the auto and the war effort spurred advances in marketing techniques. Gas could no longer be transferred from barrel to car by means of a 5-gallon can as was the custom in the earlier decade. The sidewalk pump was introduced. Often, however, automobile owners bought gas in quantity from the bulk plants, particularly in times of high gas prices. The Texas Company was the first to stress the "service station" idea as opposed to the "filling station" concept, by adding lubrication and repair services to the main function of gas supply. Brandmarks and advertising slogans were widely publicized. One company, for example, highlighted the color and weight of its gas: "Clean, Clear and Golden." Credit terms were extended by major companies to customers in times of short demand.

Export needs became acute for the first time in the history of the industry. California Standard was selling large quantities of oil to the Orient in this period. In the Gulf Coast region and on the East Coast, refineries were seeking outlets in South America and Europe. No more evident sign of the industry's maturity could be found than the fact that it was supporting the nation's demands and shipping abroad at the same time. The government showed increased interest in the industry's progress. Already in 1908 the Naval Reserves program had been established, to be continued by following administrations. In 1918 the United States Fuel Administration was set up to stabilize oil supplies and to issue procurement and distribution orders for the mobilization program. Within a short space of time, three significant oil journals came into being: the National Petroleum News (1909), the Oil and Gas Journal (1910) and the Gulf Coast Oil News (1916). By the end of this decade America was well ahead of Russia as the world's leading oil producer.

The Industry from 1920 to 1930:

The demand for fuel oil became stimulated by the appearance of the airplane industry. Chiefly a military weapon in World War I, aircraft took hold of the imagination of management and govern-

ment officials in the post-war era. Planes were enlisted in the cause of crop-dusting, mail and passenger delivery, land surveying and aerial mapping. Domestic plane production went from 789 in 1925 to 6,034 in 1929. In the period from 1926 to 1930, gasoline consumption for civil flying purposes jumped 400 per cent while gallonage for lubricants increased some 1,000 per cent. Automobile registration went from 2,500,000 in 1915 to 20,000,000 in 1925, showing the increased market demand for fuel in this industry.

Crude oil production rose to keep stride with the new market possibilities which the decade offered. National figures went from 472,183,000 barrels in 1921 to 898,000,000 barrels in 1930. In 1921 the states of Texas, Oklahoma and California together accounted for over 70 per cent of all American crude and in 1930 for almost 82 per cent. When the Ranger and Burkburnett fields began to ebb, the Mexia Fault Zone in East Central Texas took up the slack. The rebirth of Corsicana in 1923 and the discovery of the Powell field gave Texas two more "flush producers" and primed the oil boom of the period. By drilling some 1,500 feet below already known producing horizons, more oil was found at five different levels at Spindletop in 1925. This famous field produced in 1926 13,441,000 barrels and in 1927 20,751,000 barrels. By 1930 Texas produced one-third of all U. S. crude, due mainly to new discoveries in the Panhandle and East Texas. Population and land values increased concomitantly in Galveston, Houston, Port Arthur, Texas City, Beaumont and Orange. Deep-water shipping facilities were available in Texas at the San Jacinto River and the Buffalo Bayou in the Houston area, and at the Neches-Sabine canal in the Beaumont region. Construction of six of the world's largest refineries with a combined daily capacity of 365,000 barrels made the Beaumont-Port Arthur axis the largest refining center in the United States.

Through important findings at Cromwell, Seminole and Oklahoma City, Oklahoma was able to furnish one-quarter of the nation's oil in this decade. With rich resources at Coalinga, Sunset, Midway, Kern and McKittrick fields, California led the oil race from 1923 to 1926. Louisiana's new pools at Bellevue, Cotton Valley, Lockport, Rodessa and Zwolle, in addition to its experimenting with marine drilling efforts, gave this state stature among oil-producing states. Arkansas, which had only 500 wells in 1921, had by 1924 some 1,000 wells at the Smackover site alone. Struggling to come back from its halcyon days of El Dorado in 1917, Kansas witnessed feverish commercial activity at Fairport, Rainbow Bend, Gorham, the Wright Pool, the Ritz-Canton, Woshell and Hugoton. Surprisingly enough, the depression of 1921-1922 failed to reduce oil production in the Southwest.

In fact, oversupply did not discourage the appearance of new independent companies such as the Mid-Continent Petroleum Company, the Barnsdall Oil Company, Lion Phillips Oil, Skelly Oil, Sinclair, Champlin and McMan. Nor did proration keep down crude production at all. As a consequence large scale operators turned to oil storage and to forward vertical integration in order to capture a

larger share of the national market. With this came physical product differentiation and brand advertising. Because of the high fixed costs involved, large refineries could effect sizeable savings when run at 100 per cent daily capacity. The break-even point on costs was more quickly reached in a 60,000 barrel/day refinery as in a 30,000 barrel/day one. A smaller refinery was less prone cost-wise to permit cut backs on crude runs as larger refineries and for this reason forward vertical integration was sought by many oil companies in the 1920's.

Major oil companies suggested voluntary proration to check waste at a significant meeting in New York in May, 1927. At about the same time the Federal Trade Commission stressed both conservation and wise investment policies in a study called "Prices, Profits, and Competition in the Petroleum Industry." During this period state proration laws and private voluntary conservation agreements among oil producers acted as price supports in an expanding market.

The problem of pricing was important at this time because it was to bring about subsequent Congressional investigations. Often dealer outlets and service stations found it difficult to sell their mounting supplies of petroleum products; jobbers therefore appeared who bought marginal surpluses at low wholesale prices and sold them at wide profit margins. Existing retail outlets felt this keen competition. Jersey Standard opposed this price slashing with a gradual rise in prices, a policy which the public resented.

Financing was a serious concern for the oil industry during this period of rapid price fluctuations. One of the biggest sources for funds in expansion policies was from profits which were "plowed back." The average was about 60 per cent of yearly earnings. Because the industry is extremely vulnerable to the vacillations of the business cycle, large oil companies prefer equity financing to bonded indebtedness as a source of external capital formation. In the oil industry the ratio of invested capital to borrowed capital has traditionally been about six to one.

Production innovations kept pace with market expansion and industry maturation. Not only were heavier tools and bits and larger rigs used to reach greater depths, but it was found that drilling one shallow central hole with tributary holes drilled horizontally enabled the oil in neighboring faults and anti-clines to drain into the central hole. Other refinements in the production field were secondary recovery methods such as water-lift and air-lift, the core drill, the rotary electric pump, and the use of hydrochloric acid to dissolve limestone in producing wells. A real asset in Louisiana's marshlands was the portable rig and drilling barges. Both would be more fully exploited later in off-shore drilling. In Los Angeles a differential gear was introduced to change the speed of motors in drilling equipment.

In boomtown areas such as the Texas fields of Ranger, Desdemona and Breckenridge primitive equipment and techniques were still to

be found: wooden derricks, "hunch" prospecting, ox-drawn freight wagons, wasteful gushers, bogus stock operations.

As for oil transport, railroad freight tonnage reached almost 72.5 million tons, a figure not to be surpassed in the following two decades. Tankers performed yeoman service also; in 1930 the nation had 371 tankers as compared to 314 in 1921. However its percentage of world tonnage showed a relative decline, falling from 54.4 per cent in 1921 to 35.8 per cent in 1931. Pipeline mileage went from 55,260 in 1921 to 88,728 in 1930. So rapidly did the pipeline industry grow that it was starting to be considered as a separate entity rather than as an adjunct of the oil industry. Typical of this growth was the long-distance pipeline which was completed in 1929 and ran from Bayonne, New Jersey to Ohio, a town near Pittsburgh. The existence of distant concentrated markets and the highly competitive nature of the industry (which compelled every possible saving on freight costs) were important factors in the growth of the pipeline industry.

Cracking methods continued to convert less valued products into end-items of higher worth. Chemical researchers in the twenties developed bulk pressure cracking, tube still cracking, the Holmes Manley cracking process, and the Cross cracking process, to mention the most important. The Burton process was no longer the only one. This shift to better and more efficient cracking and refining methods enabled Walter Chrysler in 1924 to put on the market a high-speed, high-compression motor and thus initiate the race for high-compression ratios.

Research turned out to be so important in this decade that in 1922 Jersey Standard's research was turned over to a separate company: the Standard Oil Development Company. The phenomenal growth of petrochemicals in the 1950's had its beginnings in the early twenties when Carbide and Carbon Chemical Corporation first developed processes of synthesizing other chemicals from petroleum and natural gas hydrocarbons. Natural gas, when mixed with naphtha, was shown to be a suitable motor fuel, a discovery which had serious repercussions for the Southwest with its virtual monopoly of natural gas pools. As the industry reached the threshold of the thirties it foreshadowed the greater product differentiation and market possibilities that were to be developed in the ensuing years.

(The conclusion of this article, covering the period from 1930 to the present day, will appear in the June issue of the BUSINESS REVIEW.)

A COMPUTER ALLEVIATES INVENTORY CONTROL PROBLEMS

by

Chester C. Kennedy

EDITOR'S NOTE: On February 16 and 17, the Fourth Annual Data Processing Conference was held at the Management Center at Marquette University. Mr. Chester C. Kennedy, a Registered Professional Engineer, was among the eminent national speakers who gathered to relate their current experiences. Mr. Kennedy is responsible for the mechanization of inventory control at Cutler-Hammer, and his presentation in the following speech should be of interest to persons engaged in controlling inventories or utilizing computers.

When I was asked to make this presentation I was told that it was to enumerate some of the problems we encountered and what we did to overcome them. Before starting, however, I feel that I should first acquaint you with the equipment we are using: We have a Remington-Rand Model "O" Univac file computer, which, by the way, is plugboard programmed. With it we have one card and four tape input-output units for on-line operation. We will have, by the time the mechanization is complete, a total of ten large capacity storage drums (we have seven drums at present). Of the ten, six will be used for inventory control data and the remaining four for other computer applications. In addition to the four tape units, we have a tape sort-collate unit that operates off-line, permitting us to accept transactions in random sequence, record them on tape, and then sort sequentially off-line. To round out the equipment, we have the usual peripheral equipment — tabulators, multicontrols, sorters.

Historically, Culter-Hammer decided, about 5 years ago, to investigate the use of an electronic computer for inventory control. A guiding committee was set up for the purpose of determing how best to approach the problem. Investigation by the committee and contacts with other companies using some form of mechanized inventory control, not necessarily computers, brought them to two conclusions:

1. Every system they saw was unique and perfectly suited to the application, but unsuitable for our problems.

2. The consensus of the companies contacted was that the best approach was to have someone head up the program who was relatively unfamiliar with inventory control and relatively unfamiliar with tabulation and computer equipment.

In setting up our mechanized inventory control system, one of the first problems we encountered was "what to include in the system." Obviously, it would not be practical to include all stock items in the system. We reviewed all of our stocked items and culled out about

8,000 items that we felt could be put on a bag reserve system. These items were selected on the basis of relatively high and consistent usage, low unit cost, and low obsolescence risk — which meant we could afford to carry a high safety factor on these items and could order long-time supplies. For the present, these will be controlled on a manual system, since all that is required is that, at the time the bag reserve is broken into, someone check when the last order was placed to get a measure of the rate at which the item was used, calculate new values of bag reserve and order quantity if the rate has changed appreciably, and place the new order. The high safety stock precludes any necessity for follow-up or expediting. Incidentally, we stock a little over 50,000 items — the remaining 42,000 items being incorporated in our mechanized system. The system, as we have it set up, follows fairly close to the manual system we have developed over the years — at least it does basically. We use commitments and order, based on an available balance — on hand plus on order minus commitments minus order point. If this is negative, we place an order.

I stated earlier that the first problem we faced was to determine what items we would put on the mechanized system. Although that was really the first, the first major problem was "how much information does a scheduler need and how often should he receive it." A corollary to this might be "how many of his decisions can be made by the computer." An analysis of the decision-making required by the schedulers revealed that, as a group, the decisions were very inconsistent — which is what you might expect if you consider that they must be made based on intangibles and the scheduler's supposed familiarity with the item and its end use. This familiarity may have been possible when the scheduler had his desk next to the foreman's, and the stock room was right behind him. But in the complex business procedures of today, it is inconceivable that a scheduler can begin to know intimately the items under his jurisdiction, much less the end use of the item. We started a program of defining and wherever possible, formulating these policies, or decision-making procedures. As many as were feasible have been incorporated into our computer programs. The end result is that we operate on the basis that, as long as our available balance is positive and usage is reasonably normal, it is unnecessary for anyone to look at the balances — and they are locked in the computer, in a manner of speaking. Consequently, the only time a scheduler is given information is when some action is required. At this time he is given a "status card," which indicates the type of action required and which shows all the balances he would normally have on a ledger card. Also shown are other pertinent data, such as replenishment time, correct ordering quantity, and order point. The action required is coded on the card and could be one of the following:

1. Order action. This would occur when the on hand plus on orders is sufficient to cover open commitments, or requirements, but not sufficient to cover the order point as well.

2. Rush order action. This would occur when the on hand plus on orders is not sufficient to cover open requirements.

   If either type of order action is required, an order request is sent directly to the Routing and Material List Department by the Tabulating Department to initiate the order. The scheduler receives the status card along with the order, and schedules the order based on the status shown.

3. Deferral action. This would result either from a return to stock, from a drop in anticipated usage, or from cancellation of an open commitment. The scheduler is notified only if we have the equivalent of an order quantity on order.

4. Expedite action. Expedite action occurs when the on hand balance is less than the safety stock. A word of explanation here — our order point consists of a supply sufficient to carry us through the replenishment period with normal usage, plus a "safety stock" to serve as a buffer for delayed deliveries, increases in the rate of usage, and other contingencies. The safety stock is machine calculated and is personalized for a given item; it is based, roughly, on the unit cost of the item, the annual rate of usage, the replenishment time, and the history of the item (the relation between balances at periodic intervals). In addition to the recording of balances and testing for actions required, our system calculates new order points and based-ons monthly, prepares monthly and yearly inventory reports by categories, and recalculates C.O.Q's. quarterly. It might be of interest to know that our complete inventory control system comprises some 30 separate computer programs.

I mentioned previously that we intend to have six large capacity drums for inventory control, which will accommodate about 8,000 of the 42,000 items under mechanized control. The remaining 34,000 will be recorded on magnetic tape. By way of explanation to those of you who may not be familiar with drum and/or tape access, the drum storage provides a truly random access, whereas items are stored on tape in some sequential arrangement. Thus, transactions affecting items on tape must be in the same sequential arrangement. Also, balances on the drum can be changed in the course of a program, but in order to change a balance on an item stored on tape, the complete tape must be rewritten. Incidentally, the problem of storing on the drums for rapid access requires some sort of an addressing scheme to get you to the required record area. We ran a test on the frequency of use of each character position in our entire stock list, and from this determined a pattern for picking up our part number that would give us a maximum range. With 19 possible character positions, it is picked up as two words, added together, and the sum divided by a prime number. The remainder after this division gives us the address of the item.

The items selected for storage on the drum are the high activity items. We found that a very close approximation to the probability curve exists in the activity of our stocked items — about 15 per cent

of the items account for about 85 per cent of the activity. In order to maintain the items to be stored on the drums, each item has a field set aside for recording the number of times it is referred to. Periodic checking of this transaction count will permit us to shift items from drum to tape and tape to drum when warranted.

In our mechanized system we process all transactions affecting inventory through the computer on a daily basis, searching for the item on the drums. If not found on the drums, the transaction card is out-filed for tape look-up, which is done on a bi-weekly basis. If the item is on the drum, the proper balances are updated, action tests are made and, if action is required, the transaction paper is coded to indicate that a status check is required. These coded papers are, in turn, reproduced on a status card (part number only) and, at the completion of the transaction run, a status run is made. This is necessary in that, as I have said before, our transactions are fed to the computer in a random sequence and we could very easily have a transaction create a balance indicating action required followed by another transaction that would nullify the first. For example, a withdrawal indicating an order required, followed by a commitment cancellation that would nullify the necessity of an order, or a withdrawal indicating expedite action required followed by a receipt that would nullify the required action.

In addition to updating balances and testing for action, we also punch in the transaction card the Stores Group number, inventory classification and price, and extend if it represents an actual movement of stock, either into or out of stock. The unit cost of each item is stored on the drum as a labor and applied burden cost and as a unit material cost. The two costs presented a problem to us in finding room to store them. To begin with, data for a given item are stored in a "unit record area" on the drum. In our case this consists of a storage of 120 characters, either alpha or numeric. Since our part number alone requires 19 character positions, space was at a premium. To store the costs over the full range would require nine characters for each cost. We condensed this to four digits for each by using three significant digits in all costs and a fourth digit for a shift code. This gives us the equivalent of a floating decimal, since this shift code is delivered to the code distributor and our shift hubs are, in turn, wired to the code distributor out hubs. Incidentally, we use the same type of coding for our unit of measure conversion, which has a range of 11 characters. We store two units of measure, when necessary, for a given item — a posting unit of measure and a purchasing unit of measure, along with the proper conversion factor. For example, we use bar stock usually in feet — our routings specify feet and withdrawals are on the basis of feet. However, the purchasing unit is always in pounds, so we store both on the drum. Transactions processed in the computer are checked as to the unit of measure in the card, and if in the purchasing unit, the computer converts it to the posting unit before updating and pricing (unit costs are in terms of the posting unit).

A word regarding commitments: Commitments are considered current and are posted if the scheduled withdrawal date is within

the process time of the item. The computer checks the withdrawal date with the process time and, if it is beyond process time, the commitment is pended. These pended commitments are reprocessed weekly to determine when they become current. At the time of original processing, when it is determined that they are to be pended, the quantity is checked — if it is in excess of one month's supply a reproduced copy is sent to the scheduler, thereby giving him advance warning of large and possibly unusual requirements, for which he may wish to take some advance action. Along with this timing of commitments I might add that we use a date code calendar where all dates are given in a week-code, that is the weeks are numbered from 1 to 52. Although it is not required in our inventory control we have made provisions to add a third digit to identify the day of the week. This will be required when we mechanize our routings and incorporate scheduling and material listing. This project is being worked on and is possibly a year away.

Since this talk is limited — and it is impossible to list all the problems encountered over four years of establishing a workable system, I have tried to list the ones I felt would be of interest. I would like to conclude the presentation by elaborating on the problem of human errors. I think these are by far the most serious problems encountered. You can logically reason your way out of situations created by mechanized handling because, after all, the only limits on what the computer can do is the ingenuity of the programming staff. However, it is impossible even to foresee the possibilities of error that can be introduced by the natural ability of human beings to err. The only solution I can recommend is along the lines of what we are doing.

First of all, we set up a staff whose chief assignment is the education and training of all Stores personnel. This includes writing up all procedures in Stores nomenclature — which I insist is some unclassified foreign language.

A secondary purpose of this staff, and one that will increase as the education and training near completion, is that of liaison between the Tabulating and Stores Department when errors creep in, or are suspected. This is necessary in our system since we have close to 100 stores groups, representing between 70 and 80 schedulers. It would be expecting the impossible to have that many people sufficiently acquainted with the mechanical end to be able to follow up on suspected trouble. Also, the trouble that occurs once a year to the individual scheduler happens 70 to 80 times a year to the staff.

The other approach we have to the problem is a series of check programs — for example, open order versus receipts, open commitments versus withdrawal, and check limits on usage variations. To be able to investigate any unusual conditions pointed up by these check programs, we do a periodic unloading of all pertinent data to a tape. Transactions processed within these periods of unloading are recorded on tape simultaneously with their processing. Thus, if an unusual condition is found to exist, we can go back and reconstruct from a point where conditions were normal.

I hope I have accomplished what I set out to do — acquaint you with a few of the problems we encountered and our solutions, good or bad, to these problems. Of one thing I'm certain — if you are planning on going into computer inventory control, you will run into a few of the problems we did, and many more that we did not. Inventory control, and I think especially computer inventory control, presents unique problems in each application. You may find a clue to a solution in another application, but the end result must be your own.

OFFICE MANAGEMENT - - SCOPE OF RESPONSIBILITIES

by

Orville H. Palmer*

The area of management least uniformly defined as to scope and most lacking in identification with specific duties is that of office management. The breadth of the area which is encompassed by office management is reflected in the *Dictionary of Occupational Titles,*[1] which defines an office manager as "any individual who supervises and directs clerical employees in the business office of an establishment, hires and discharges employees, assigns duties, coordinates the work of the office with other departments, and performs other supervisory duties. An office manager may actively engage in one or more clerical duties, such as keeping books or making up payroll." John J. W. Neuner in his book *Office Management — Principles and Practices*[2] gives the following description of the functions of an office manager. "Although many executives have an imaginary picture of what an office manager's functions are, when it comes to a specific illustration of just what his duties are, the variety of responsibilities placed upon him is almost as great as the number of types of business firms. No two office managers have the same job responsibilities."

Both quotations direct attention to the difficulty encountered when an organization is establishing the position of an office manager; when a school is attempting to develop potential office managers; when an association of office managers is planning a program to meet the needs of its members.

The Board of Directors of the Milwaukee Chapter of the National Office Management Association recognized in 1957 the need for exploring the field of office management to determine, if possible, areas of responsibility which most frequently fall under the jurisdiction of an office manager. The Research and Survey Committee of the Chapter was instructed to conduct a survey that would identify those areas. The principal objective of the survey was to provide a base on which to build programs to serve the membership better. In addition it was felt that the study could provide a starting point for definition of the areas in which office management should operate and that it could thereby serve both industry and education.

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*Mr. Palmer is Assistant Dean and Associate Professor in the College of Business Administration of Marquette University. The study which provided the basis of this article was conducted by him for the Milwaukee Chapter of the National Office Management Association under the direction of the Research and Survey Committee. Mr. Palmer is First Vice President of the Milwaukee Chapter of NOMA.

1. U. S. Dept. of Labor, *Dictionary of Occupational Titles,* Second edition, Vol. 1, U. S. Government Printing Office, March, 1949.

2. John J. W. Neuner, *Office Management,* Fourth Edition, Southwestern Publishing Company, 1959; p. 8.

The study was based on the membership of the Milwaukee Chapter of the National Office Management Association. The membership at the time of the study consisted of 223 men and 20 women representing about 150 organizations. Of the 243 questionnaires mailed, 134 were returned.

A direct transcript from the 134 respondents revealed that they operated under 90 distinct job titles which recalls the statements made by John J. W. Neuner previously quoted on page one, "no two office managers have the same job responsibilities." A detailed review of the titles, relating them to the duties described, divided the 134 respondents into two principal categories. Fifty-five respondents operated under a title which reflected office management duties. The balance, 79, had titles which would not indicate office management duties. However, in all cases describing duties performed, each of the 79 indicated a major responsibility in at least one office management function.

This could lead to the conclusion that the responsibilities of managing the office should not be isolated and identified solely with an office manager; rather, it would seem more logical to recognize that any individual who performs his work in an office must, in addition to other duties, be an office manager. A bit of reflective thinking together with the observation of several offices further substantiates this position.

This report, then, concerns itself not with the term office manager, nor with what he does, but with what the areas of office management are, recognizing that anyone who operates out of an office will have these problems in some degree.

The respondents to the NOMA questionnaire identified four major areas of responsibility. The areas are identified as office services, office personnel management, office systems and procedures, and office building operation and maintenance. A review of other publications in the field of office management also supports the break down into the above four areas. For example, George Terry in *Office Management and Control*[3] lists six areas: specifying and purchasing of office equipment, maintaining service and communication facilities, controlling office activities, maintaining satisfactory employee-employer relationships, analyzing and improving office methods and procedures, and maintaining desirable physical facilities of the office. The first three items listed were consolidated into office services in this study. Other texts reflect similar areas.

As a starting point, then, it is established that a person having the responsibility of managing an office must provide office services, develop systems and procedures pertaining to office work, manage office personnel and be responsible for the operations and maintenance of the office itself. In evaluating the amount of responsibility each

3. George Terry, *Office Management and Control*, First Edition, Irwin Publishing Company, 1949; pp. 10-11.

respondent had regarding particular duties, four gradations were used. Full responsibility represented a respondent who had company-wide responsibility for a particular duty. If the duty represented one handled by each individual office, then it was considered a joint responsibility. That is, company-wide, several individuals would have this duty as a responsibility. There were two additional categories covering those duties performed as a committee responsibility, and those which constituted an advisory responsibility.

In Table I, which uses the four classifications referred to above plus accounting, which also appeared frequently among the respondents' duties, it will be noted that office services ranked as the type of responsibility for which the greatest number of respondents were fully responsible. Personnel administration ranked second.

TABLE I

DUTIES PERFORMED BY 134 MEMBERS
MILWAUKEE CHAPTER OF NOMA
TABULATED ACCORDING TO FREQUENCY OF
ACKNOWLEDGED RESPONSIBILITY

	Degree of Responsibilities				
Area	Full	Joint	Committee	Advisory	None
Accounting	44	15	2	5	68
Personnel Administration	47	41	4	18	24
(For Office Employee) Office Services	73	17	0	13	31
Systems and Procedures	32	47	4	22	29
Office Building Operations and Maintenance	19	23	1	30	61
Other Functions	3	10	1	17	103

In addition to being fully responsible for office services company-wide, nearly one-half of the respondents were responsible for the systems and procedures and to an almost equal degree for the management of personnel within their own department. The table also reveals that the members are looked to for advice on office building operations and maintenance more frequently than for any other function.

The above analysis leads to the conclusion that, as reflected in this study, any individual managing an office will be responsible for the company-wide office services, the management of office personnel and the development of office methods and procedures.

The Office Service Function

Since the area of office services was reflected as the one in which most managers of offices had company-wide responsibility, a more detailed examination of duties included in this area was made.

Providing mail service was the most frequently acknowledged full responsibility of an office manager. Fifty-eight per cent of the respondents reported this service as being solely within their jurisdiction. However, when the data were examained to include responsibility not only company-wide, but also within a department and on an advisory basis, there were four other activities which were more frequently identified as duties of an office manager. Eighty per cent of the respondents reported that they either purchased or aided in purchasing office furniture and equipment. An equal number were responsible for maintaining or advising on the maintenance of the filing system and its corollaries, records storage and records retention. The third group of duties included purchasing, maintaining and operating office machines. Finally, those responsible for managing an office were charged with maintaining messenger, reception and information services.

An additional ten groups of duties were reported with great frequency. Briefly, then, the above reflects the duties of an office manager in the area of providing office services.

Managing Office Personnel

The analysis of duties performed as reflected in the study disclosed that the management of office personnel ranked second to office services as a full responsibility among the members of the Milwaukee Chapter of NOMA. (See Table I, page 38) Quoting from *Office Management* written by Charles Hicks of Ohio State University and Irene Place of the University of Michigan, "The office manager may or may not be directly concerned with the personnel function, but he is concerned with personnel. He is interested in specific personnel principles and techniques as they apply to office workers."[4]

It is estimated that the cost of recruiting, selecting, orienting, training and supervising a new employee until he reaches a productivity that offsets his wage is between $300 and $400. Each failure on the part of an office manager to select and retain a competent employee is costly. In the study of the members of the Milwaukee Chapter of the National Office Management Association, it was determined that from 60 per cent to 75 per cent of those responsible for managing offices concerned themselves with problems of managing office personnel. Out of 134 respondents to the questionnaire, 103 or 76 percent were responsible for interviewing and selecting office employees for the company. A slightly smaller group, totaling about 60 per cent of the respondents, reported either company-wide or department responsibility for job evaluation, job analysis, employee rating and training.

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4. Charles Hicks and Irene Place, *Office Management*, Allyn and Bacon, 1956; p. 309.

It is concluded that responsibility for management of office personnel is an important part of the job held by office managers. A question which logically follows is, "How big is this job, in terms of number of employees?" The answer to this question is likely to vary with the community being examined.

For the Milwaukee area, as reflected by the study previously quoted, somewhat more than 40 per cent of the respondents represented companies with less than 100 office employees. About the same proportion represented companies with between 100 and 500 office employees.

To analyze further the probable responsibilities for personnel, the study determined the actual number of employees supervised by the respondents. Fifty-three per cent of the respondents supervised less than 50 employees. By comparison, 18 per cent supervised over 100 employees.

Further light is cast upon the supervisory responsibility of managers of offices by an examination of the number of respondents who supervised supervisors. One hundred and twenty-seven respondents indicated that they supervised one or more employees. When the data were further examined, 105 stated that at least one of the employees supervised was a supervisor in his own right. That is, many of the members not only supervised directly productive employees, but also supervised at least one who was directing the work of others. However, 42 per cent had the responsibility of only 1, 2, or 3 supervisors under their direction.

In addition to the supervision of productive employees and of other supervisors, the respondents indicated one special problem in supervision — 65 out of 134 respondents or about 50 per cent had the responsibility of supervising the work of employees who were not directly under their supervision.

This is likely to cover the situation of the office manager who is responsible for the messenger service of an organization although certain messengers may be assigned directly to a particular department. The data on number and type of employees supervised, together with the data on the size of the organization, further point up the fact that most office managers are likely to be interested in the problems of a relatively small office. This, too, undoubtedly accounts for the reason that the respondents reflected a responsibility for a wide variety of duties. That is, the manager of a small office is likely to have a greater number of varied duties than is his counterpart in a large office which operates with greater specialization.

While the above study reflects the personnel management duties of office managers, it is likely that the large number of small and medium size businesses in other industrial areas would also reflect similar responsibilities.

Systems and Procedures as a Responsibility

Ranked almost equally with administrating office personnel was the responsibility for the systems and procedures for the company as

a whole or for the department in particular. It ranked fourth as a full company-wide responsibility, but first as a department responsibility. There were four areas within systems and procedures work for which between 55 per cent and 60 per cent of the respondents indicated responsibility either on a company-wide basis or within a department. The preparation of procedures manuals was a full responsibility of 41 out of 134 respondents. It ranked first as a full responsibility among the systems and procedures functions. Among the joint responsibility functions — that is, for a department only — systems analysis, systems recommendations, and systems reorganizations stand as the most frequent. This is closely followed by the areas of work simplification and measurement, and of forms design and control.

It should be noted that responsibility for systems and procedures is not as universal as are the two prior areas discussed.

Office Building Maintenance and Operations as a Responsibility

From the data gathered it can be concluded that but few office managers have a specific responsibility for either the operation or maintenance of an office building or that portion of the building housing the offices. In the study made, those who reported full responsibility in this area totaled 19; this is only 14 per cent of the respondents. The data indicated that the members were more likely to be called upon in an advisory capacity, but even this was limited to 30 respondents or 22 per cent of the total. Close to half of those reporting (46 per cent) reported no responsibility for the maintenance and operation of the building.

Even in connection with specific duties in the area of building maintenance and operation, only a relatively small group of respondents reported any responsibility. Those reporting specific duties tended to center them in the area of cleaning and maintenance. It was also noted that the manager of the office was frequently called upon to advise on lighting, decorating and so forth.

Based on the study made by the Milwaukee Chapter of the National Office Management Association, an office manager will be basically responsible for providing office services for the company as a whole; to select, train and supervise the office personnel; to a lesser degree develop office procedures; and advise on rather than have direct responsibilities for operation and maintenance of the office building.

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